INDOOR AIR QUALITY ASSESSMENT

Dean S. Luce Elementary School
45 Independence Street
Canton, MA

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
September 2017

Background

Building:	Dean S. Luce Elementary School
Address:	45 Independence Street, Canton, MA
Assessment Requested by:	Canton Public School Department and Canton Teacher's Union
Reason for Request:	Concerns about indoor air quality (IAQ) and chronic illness.
Date of Assessment:	June 1, 2017
Massachusetts Department of Public Health/Bureau of Environmental Health (MDPH/BEH) Staff Coordinating/Conducting Assessment:	IAQ Program staff: • Mike Feeney, Director • Cory Holmes, Environmental Analyst/Inspector Community Assessment Program (CAP) staff: • Brenda Netreba, Environmental Analyst • Erin Collins, Epidemiologist
Building Description:	A one-story concrete and brick building with a flat roof.
Year Built:	Originally constructed in 1954; a second wing was added in 1999.
Building Population:	The school houses a student population of approximately 490 and a staff of approximately 75.
Windows:	Openable

Methods

Please refer to the IAQ Manual for methods, sampling procedures, and interpretation of results (MDPH, 2015).

IAQ Testing Results

The following summarizes indoor sampling results at the time of assessment (Tables 1).

- ***Carbon dioxide levels*** were below 800 parts per million (ppm) in the majority of areas tested (39 of 47). MDPH recommends that carbon dioxide levels be maintained at 800 ppm or below. This is because most environmental and occupational health scientists involved with research on IAQ and health effects

have documented significant increases in IAQ complaints and/or health effects when carbon dioxide levels rise above the MDPH guideline of 800 ppm for schools, office buildings and other occupied spaces (Sundell et al., 2011).

- ***Temperature*** was within the recommended range of 70°F to 78°F in all areas tested.
- ***Relative humidity*** was within or close to the recommended range of 40 to 60% in the areas tested.
- ***Carbon monoxide*** levels were non-detectable (ND) in all areas tested.
- ***Fine particulate matter (PM2.5)*** concentrations measured were below the National Ambient Air Quality Standard (NAAQS) level of 35 $\mu g/m^3$ in all areas tested.
- ***Total Volatile Organic Compounds (TVOCs)*** levels were ND in areas tested.

Ventilation

A heating, ventilating, and air conditioning (HVAC) system has several functions. First it provides heating and, if equipped, cooling. Second, it is a source of fresh air. Finally, an HVAC system will dilute and remove normally occurring indoor environmental pollutants by not only introducing fresh air, but by filtering the airstream and ejecting stale air to the outdoors via exhaust ventilation.

Fresh air in classrooms is supplied by unit ventilator (univent) systems (Picture 1). A univent draws air from outdoors through a fresh air intake located on the exterior wall of the building (Picture 2) and returns air through an air intake located at the base of the unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. In a number of classrooms, items placed on and/or in front of univents obstructed normal airflow (Pictures 1, 3 and 4).

Exhaust ventilation for classrooms in the 1999 addition is provided by ceiling vents ducted to rooftop motors (Picture 5). The location of some exhaust vents (i.e., above the hallway door) can limit exhaust efficiency (Picture 6). When a classroom door is open, exhaust vents tend to draw air from both the hallway and the classroom. The open hallway door reduces the effectiveness of the exhaust vent to remove common

environmental pollutants from classrooms. Exhaust vents in the 1954 wing are located in floor level "cubbies" ducted to rooftop motors. Many of the exhaust cubbies were obstructed and/or being used for storage of items, limiting airflow (Pictures 7 and 8). Without exhaust ventilation, normally-occurring environmental pollutants can build up, leading to indoor air/comfort complaints.

Mechanical ventilation in interior rooms and common areas (e.g., gym, auditorium) is provided by rooftop or ceiling-mounted air-handling units (AHUs). Fresh air is distributed via ceiling-mounted air diffusers (Picture 9) and ducted back to AHUs via ceiling or wall-mounted return vents.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

Microbial/Moisture Concerns

Water-damaged ceiling tiles were observed in the media center hallway/entrance (Picture 10), which are reportedly the result of a chronic roof/building envelope leak that the school department has been attempting to investigate/repair. This area contains wall to wall carpeting, which also has been repeatedly moistened.

Outside the building, plants were observed next to the foundation (Pictures 2 and 11), which can hold moisture against the side of the building and lead to deterioration as well as damage due to root infiltration. In addition, nearby plants can be a source of pollen and debris which can clog univent filters and infiltrate through open windows.

Indoor plants were observed in several areas (Table 1). In one case, plants were observed on top of paper towels (Picture 12), which are a porous material that can grow mold if wetted repeatedly. Plants, soil, and drip pans can serve as sources of mold/bacterial growth. Plants should be properly maintained, over-watering of plants should be avoided, and drip pans should be inspected periodically for mold growth. In

addition, plants should not be placed on top of or in the airstream of HVAC equipment such as univents.

Volatile Organic Compounds (VOCs)

Exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat, and/or respiratory irritation in some sensitive individuals. To determine if VOCs were present, BEH/IAQ staff measured TVOCs in the areas assessed; no measureable levels were observed. Good ventilation is required to remove irritants from cleaning chemicals. BEH/IAQ staff also examined rooms for products containing VOCs. BEH/IAQ staff noted hand sanitizers, cleaners, air deodorizers and dry erase materials in use within the building (Table 1). All of these products have the potential to be irritants to the eyes, nose, throat, and respiratory system of sensitive individuals. Photocopiers and laminators were located in the teacher's work room. Photocopiers can emit ozone and TVOCs, especially when they are older or heavily used, laminators give off waste heat and plastic odors.

Other IAQ Evaluations

Other conditions that can affect IAQ were observed during the assessment. Portable air conditioning (AC) units are equipped with filters, which were found dirty in several areas (Picture 13). Filters for AC units should be cleaned prior to and periodically during the cooling season.

BEH/IAQ staff examined univent filters, which appear to be a low grade mesh-type that provides minimal filtration (Picture 14). The MDPH recommends pleated filters with a Minimum Efficiency Reporting Value (MERV) of 8, which are adequate in filtering out pollen and mold spores (ASHRAE, 2012). Note, however, that an increase in filtration can cause stress on equipment, which needs to be evaluated to determine if the higher-rated filters will allow adequate function. Filters should also be changed two to four times a year, or per the manufacturer's recommendations.

Some flat surfaces, vents, and personal fans were found to be dusty (Pictures 5, 9, 15 through 17, Table 1). Dust can be reaerosolized and cause irritation; flat surfaces,

vents, and items should be cleaned regularly with a high-efficiency particulate arresting (HEPA) vacuum or wet wiped.

In many areas, accumulated items, including books, papers, toys and decorative items were observed on floors, windowsills, tabletops, counters, bookcases, and desks (Pictures 3, 4, 18 and 19), which can make it more difficult for custodial staff to clean.

Note that the Environmental Protection Agency (EPA) conducted a National School Radon Survey in which it discovered nearly one in five schools had "…at least one frequently occupied ground contact room with short-term radon levels above 4 [picocuries per liter] pCi/L" (US EPA 1993). The BEH/IAQ Program therefore recommends that every school be tested for radon, and that this testing be conducted during the heating season while school is in session in a manner consistent with USEPA radon testing guidelines. Radon measurement specialists and other information can be found at www.nrsb.org and http://aarst-nrpp.com/wp, with additional information at: http://www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/exposure-topics/iaq/radon.

Health Concerns

At the request of administrators of the Canton Public Schools, BEH staff from the Community Assessment Program (CAP) and the Indoor Air Quality Program (IAQ) attended a meeting on April 25, 2017 with several teachers of the Canton Public Schools who had health and building concerns. This meeting was also attended by their Union Representative and representatives of the Massachusetts Teachers Association as well as the Superintendent and Business Administrator for Canton Public Schools. In response to the specific concerns that were raised at the meeting, CAP staff conducted in-person interviews with interested employees of the Luce Elementary School on June 01, 2017 and also offered to conduct interviews over the phone for those unable to attend on that day. IAQ staff conducted an indoor air quality assessment of the building the same day.

The interviews included the administration of a questionnaire by BEH/CAP staff to obtain information on the type and frequency of symptoms experienced by some employees as well as employment history and residential history. The questionnaire was closely modeled on surveys used previously by BEH as well as those used by the

National Institute of Occupational Safety and Health (NIOSH) and the U.S. Environmental Protection Agency (US EPA). The questionnaire elicited information on specific symptoms that have been reported in the scientific/medical literature as commonly experienced by occupants of buildings with indoor air quality problems as well as information on perceived air quality and personal health factors. These types of questionnaires are used to systematically collect building-related health and environmental complaints. The information collected, in conjunction with the assessment of the indoor environment, can be used to evaluate possible associations between indoor air quality and health and to recommend appropriate follow-up, if warranted.

The Luce Elementary School has an employee population of approximately 75 individuals. Four individuals (5%) participated in the BEH interview. All responses were reviewed to identify the types of diseases and symptoms that were reported, their frequency of occurrence, and whether any unusual patterns emerged suggestive of a possible association with indoor environmental conditions at the school.

Employee Interview Results

A total of four current employees participated in the interviews. Due to the small number of participants, limited information about health effects and indoor air quality concerns experienced within the last 4 weeks (of the time of the interview) and additional health and building related concerns was collected. Under both state and federal regulations, personally-identifying information shared by employees is confidential; therefore, the following discussion provides summary information only.

Health Effects

The average age of the four employees who participated in the interviews was approximately 53 years old and the average length of employment at the school was 16 years. Smoking status was obtained in the interviews due to the role of smoking in respiratory health.

The most commonly reported symptoms (with at least three of the four employees reporting that they experienced the symptom at least once in the four weeks prior to the interview) were: dry, itching, burning, watering or irritated eyes; stuffy or runny nose or

sinus congestion not related to an infection; headaches; and unusual tiredness, fatigue, or drowsiness. Respondents were asked if they experienced these symptoms primarily inside the building, outside the building, or both. The majority of the employees who reported experiencing headaches or stuffy/runny nose or sinus congestion reported experiencing these symptoms mostly inside the building. The majority of the employees who reported experiencing dry, itching, burning, watering, or irritated eyes, or unusual tiredness, fatigue, or drowsiness reported that they experienced symptoms both inside and outside the building. Respondents were asked if there was a particular time of day or week when their symptoms became worse or occurred more frequently. Overall, there did not appear to be a consistent pattern among respondents with most employees reporting no observable pattern over the course of a week, and identifying different times of day when their symptoms seemed worse.

Concerned employees were also asked if they had been diagnosed by a doctor with any of the following conditions: asthma, eczema, hay fever, or migraine headaches. Of these conditions only migraines were reported as diagnosed by a doctor.

The employees who participated in the interviews were asked if they had any other health-related concerns at the Luce Elementary School that had not yet been discussed. A concern was raised about the incidence of cancer among employees, particularly some past employees who no longer work at the Luce Elementary School.

Building Concerns

BEH/CAP staff also asked employees several questions about their perceptions of environmental conditions in their work surroundings. The most commonly reported conditions as reported by at least three of the four employees were as follows: air was too humid; air was too stuffy; and indoor air temperatures were too cold. Most employees noted that conditions within the building varied depending on the season, and that some things such as moldy odors were worse during particular times of the year.

All employees who participated in the interviews were asked if they had any other building-related concerns at the Luce Elementary School that had not yet been discussed. A variety of concerns were raised, including the following:

- Dirt and dust blowing out of furnaces when they are turned on.

- Leaks in the walls, ceiling, and windows in various parts of the building.
- Humidity issues.
- Historical and ongoing issues with mold on surfaces inside the building.
- Uncertainty about the quality of the drinking water.
- Suspicion that the school may have been built on a former dump.

Symptomology and Building Location

The locations where individuals reported working in the building and their health concerns were evaluated with respect to the results from the environmental testing conducted by BEH/IAQ staff. All employees reported that there were specific locations within the building where they spend the majority of their time. All individuals reported working primarily in one location throughout the course of a given day.

Health Discussion

The respiratory/irritant and other symptoms reported among participants in this health investigation are generally those most commonly experienced in buildings with indoor air quality problems. These included itchy, runny, or watery eyes; stuffy or runny nose or sinus congestion not related to an infection; headaches; and unusual tiredness, fatigue or drowsiness. Such symptoms are commonly associated with ventilation problems in buildings, although other factors (e.g., odors, microbiological contamination) may also contribute (Passarelli, 2009; Norbäck, 2009; Burge, 2004; Stolwijk, 1991). All areas tested during BEH's inspection on June 1 had carbon dioxide levels below the recommended limit of 800 parts per million. Results from environmental sampling indicate a number of opportunities for exposure to allergens, i.e., potential mold growth from water damage and dust. Given that exposure to excessive dust and mold can exacerbate pre-existing symptoms (e.g., asthma, allergies), it is possible that some individuals may react to mold and excessive dust differently than the general population. Allergic responses include hay fever type symptoms such as runny nose and red eyes. It is important to note that the onset of allergic reaction to triggers such as mold/moisture can be either immediate or delayed.

Cancer Concerns

Concerns about cancer, particularly breast cancer, were raised by many of the individuals who attended the initial meeting on April 25, 2017 and by at least one individual interviewed on June 1, 2017. According to the American Cancer Society, one out of three women and one out of two men develop cancer in their lifetime, and cancer will affect three out of every four families (ACS 2016). For this reason, cancers often appear to occur in "clusters," and it is understandable that someone may perceive that there are an unusually high number of cancer diagnoses in their neighborhood, workplace or town. Upon close examination, many of these "clusters" are not unusual increases, as first thought, but are related to such factors as local population density or a concentration of individuals who possess related behaviors or risk factors for cancer. Some, however, are unusual; that is, they represent a true excess of cancer in a workplace, a community, or among a subgroup of people. A suspected cluster is more likely to be a true cancer cluster if it involves a high number of diagnoses of one type of cancer in a relatively short time period rather than several different types diagnosed over a long period of time (i.e., 20 years), a rare type of cancer rather than common types, and/or a large number of diagnoses among individuals in age groups not usually affected by that cancer. These types of clusters may warrant further public health investigation.

The Massachusetts Cancer Registry (MCR), a division in the MDPH Office of Data Management and Outcomes Assessment, is a population-based surveillance system that has been monitoring cancer incidence in the Commonwealth since 1982. All new diagnoses of invasive cancer, along with several types of in situ (localized) cancer, occurring among Massachusetts residents are required by law to be reported to the MCR within six months of the date of diagnosis (M.G.L. c.111. s 111b). This information is collected and kept in a confidential database. Data are collected and reviewed for accuracy and completeness. Individuals diagnosed with cancer in Massachusetts are reported to the MCR based on their residence at diagnosis and not their workplace. For that reason, calculating an expected rate of cancer is difficult at best for a place of employment, such as a school. The most practical first step in evaluating cancer in the workplace is to determine the types of cancer reported and whether they represent an unusual pattern.

In Massachusetts, breast cancer has been the most common type of cancer diagnosed among female residents for more than a decade. During 2009 - 2013, this cancer type accounted for approximately 29% of new cancers diagnoses among females in the Commonwealth (MCR 2016). The chance of developing invasive breast cancer at some time in a woman's life is about 1 in 8 (12%). A woman's risk of developing breast cancer increases with age, with age being the strongest risk factor for breast cancer. About 1 out of 8 invasive breast cancers are found in women younger than 45. About 2 out of 3 invasive breast cancers are found in women age 55 or older (ACS 2015). Several studies have found that women who work in professional jobs tend to have an increased risk of developing breast cancer (Ruben et al. 1993; Threlfall et al., 1985; MacArthur et al., 2007; King et al., 1994; Pollan and Gustavsson, 1999) while other studies have not (Calle et al., 1998; Petralia et al., 1999). No occupational exposures have been identified in these studies. Rather, researchers suspect that established risk factors for breast cancer such as later maternal age at first birth and lower parity (the number of times a woman has given birth) may be more prevalent in women working in a professional setting than in women who do not (such as homemakers). A more detailed discussion of breast cancer risk factors can be found in Appendix A.

Many cancers occur because of changes to cells that happen by random chance. These are called sporadic or spontaneous mutations and are not due to any particular exposure to a cancer-causing agent (i.e., carcinogen). Other times, exposure may be an initiating or contributing factor to the development of cancer in an individual. The latency period is the time interval between exposure to a carcinogen and the appearance of symptoms of the disease or its diagnosis. Cancer, in general, has a long latency period but it may vary depending on the type, magnitude, and timing of the exposure. Cancers that are solid tumors, such as breast cancer, are believed to have a long latency period, estimated to be no shorter than 10 years and possibly as long as 50 years or more (Hall 2006; NRC 2005; UNSCEAR 2000; Bang 1996; Frumkin 1995). Due to the long latency period for most types of cancer, it is difficult to identify exposures that may have contributed to an individual's cancer development. It is likely that multiple risk factors influence the development of most cancers. In addition, an individual's risk of developing

cancer may change over time and may depend upon a complex interaction between their genetic makeup and exposure to a cancer-causing agent.

Other Building Concerns

The quality of the drinking water at the Luce Elementary School was raised as a concern. The drinking water for the school is supplied by the town of Canton, which receives about 80% of their water from local wells and 20% from the Massachusetts Water Resources Authority (MWRA) regional water system. A review of the 2015 Water Quality Report revealed no violations of state and federal drinking water standards in the municipal water supply (Canton DPW, 2017). It should be noted, however, that lead can get into water through plumbing and some service lines. In October 2017, testing results showed that lead and copper levels at the Luce Elementary School were below EPA's action levels for these metals (MassDEP, 2017a).

A suspicion that the school may have been built on a former dump was also raised as a concern. MDPH/BEH staff investigated the history of the location and did not find any evidence that the site had been used as a dump prior to the construction of the school in 1954. Based on records from MassDEP, the only closed landfill in Canton is now a transfer station, located about 1 mile from the school on Pine Street (MassDEP, 2017b).

Conclusions/Recommendations

Health Conclusions

Due to the small number of participants, limited information about health and building related concerns was collected. The respiratory/irritant and other symptoms primarily reported among participants in this health investigation (including itchy, runny, or watery eyes; headaches; unusual tiredness, fatigue or drowsiness; and stuffy or runny nose or sinus congestion not related to an infection) are generally those most commonly experienced in buildings with indoor air quality problems and are commonly associated with ventilation problems in buildings.

Although the incidence of cancer among employees of the Luce Elementary School was a concern expressed by several of those who attended the meeting on April 25, 2017 and by at least one individual interviewed on June 1, 2017, it is important to consider the following:

- Different types of cancer are individual diseases with separate causes and risk factors.
- Cancers in general have long latency or development periods that can range from 10 to 50 years in adults, particularly for solid tumors such as breast cancer.
- A great deal of research has been reported and more is being done to understand possible environmental influences on breast cancer risk. To date, however, there are no established environmental risk factors.
- The development of most cancers is likely influenced by multiple risk factors, while others are due to random changes in cells and occur for no apparent reason.

Indoor Air Quality Conclusions

The following recommendations are made to assist in improving IAQ:

1. Operate all supply and exhaust ventilation equipment continuously during occupied periods.
2. Ensure all exhaust vents are operating, make repairs as necessary. Check exhaust vents for air draw periodically.
3. Remove items and furniture blocking univents and exhaust vents. Reconfigure classrooms; relocate teacher's desks/work stations *away* from univent areas, for examples see Pictures 19 and 20.
4. Use openable windows to supplement fresh air during temperate weather. Ensure all windows are tightly closed at the end of the day.
5. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
6. Continue to investigate and make repairs to leaks in the Media Center (and/or other areas where water damage occurs). Replace water-damaged ceiling tiles.

7. Consider removing carpeting in the Media Center hallway (where chronic leaks occur) and replacing with non-porous floor covering (e.g., vinyl tiles).
8. Indoor plants should be properly maintained and equipped with drip pans to prevent water damage to porous building materials and be located away from ventilation sources to prevent the aerosolization of dirt, pollen, or mold. Do not rest plants on porous materials (e.g., cloth, paper).
9. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
10. Ensure that condensation from AC equipment is draining properly. Check collector pans, piping and any associated pumps for clogs and leaks and clean periodically to prevent stagnant water build-up and remove debris that may provide a medium for microbial growth.
11. Reduce use of products and equipment that create VOCs and ozone; only use in well-ventilated areas. Avoid the use of air freshening products including plug-ins and sprays.
12. Ensure exhaust ventilation is operating in areas with photocopiers and laminators.
13. Consider upgrading to a pleated filter of MERV 8 (or higher) in univents and AHUs, if these can be used with the current equipment. Change filters 2-4 times a year, or as manufacture recommends.
14. Regularly clean/vacuum univent cabinets, supply/return vents and fans to avoid aerosolizing accumulated particulate matter.
15. Consider reducing the amount of items stored in classrooms to make cleaning easier. Periodically move items to clean flat surfaces.

16. Clean window and portable AC filters prior to and periodically/as needed during the cooling season.
17. Reduce the use of air deodorizers, cleaning products, sanitizers, and other products containing VOCs. Considering adopting green cleaning procedures. Ensure cleaning products are properly labeled, and keep material safety sheets on file.
18. Consider adopting the US EPA (2000) document, "Tools for Schools", as an instrument for maintaining a good IAQ environment in the building available at: http://www.epa.gov/iaq/schools/index.html.
19. The school should be tested for radon by a certified radon measurement specialist during the heating season when school is in session. Radon measurement specialists and other information can be found at: www.nrsb.org, and http://aarst-nrpp.com/wp/.
20. Refer to resource manual and other related IAQ documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: http://mass.gov/dph/iaq.

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Picture 1

Classroom univent, note items in front of return vent (bottom)

Picture 2

Univent fresh air intake, note plants

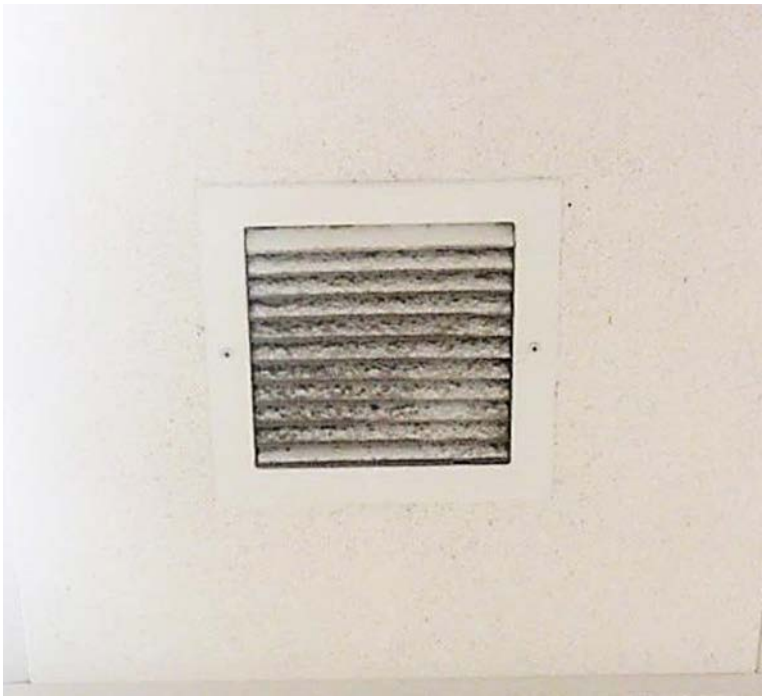
Picture 3

Classroom furniture/items around univent obstructing airflow

Picture 4

Classroom furniture/items on/around univent obstructing airflow

Picture 5



Ceiling-mounted exhaust vent for 1999 wing, note dust/debris accumulation

Picture 6

Proximity of exhaust vent to open classroom door (arrows)

Picture 7

Exhaust cubby used for storage of items

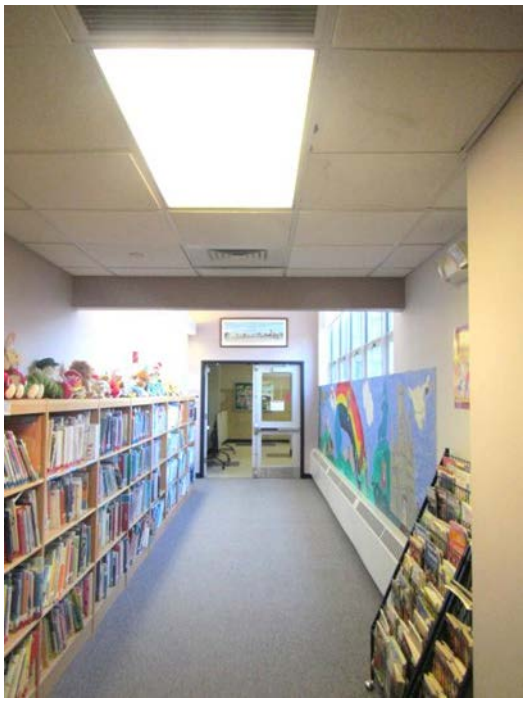
Picture 8

Classroom furniture blocking exhaust vent (arrow)

Picture 9

Ceiling-mounted supply diffuser, note dust/debris accumulation on louvers

Picture 10



Media Center hallway/entrance/site of chronic roof leaks

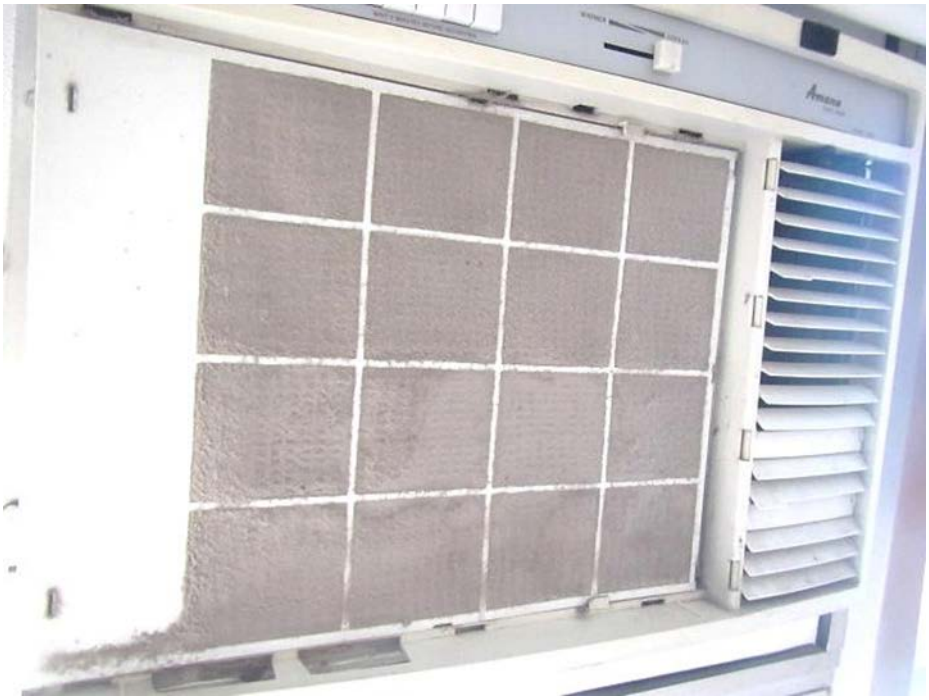
Picture 11

Plants growing against foundation/exterior wall

Picture 12

Plants on paper towels

Picture 13



Dirty AC filter

Picture 14

Univent filter

Picture 15

Dust/debris on windowsill

Picture 16

Dust/debris on windowsill

Picture 17

Dust/debris on blades cage of portable fan

Picture 18

Accumulated classroom items on flat surfaces

Picture 19

Accumulated classroom items on flat surfaces, note file cabinet/teacher's desk/work station configured around univent

Picture 20

Teacher's desk relocated *away* from classroom univent (arrows)

Location: Dean S. Luce Elementary School **Indoor Air Results**

Address: 45 Independence Street, Canton, MA **Table 1** **Date: 6/1/2017**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	TVOCs (ppm)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
Background	385	ND	80	46	2	ND					Clear, sunny
Main Office	574	ND	73	51	1	ND	1	Y	Y	Y	
6 Principal's Office	538	ND	74	50	1	ND	0	Y	Y	Y	Wall to wall carpeting, dust/debris on vents
9 Health	574	ND	74	49	1	ND	4	Y	Y	Y	DO
12	658	ND	75	47	1	ND	14	Y	Y	Y	DO
13	405	ND	76	40	1	ND	19	Y	Y	Y	UV and exhaust blocked, exterior door open, PF, DO
14	697	ND	74	52	2	ND	1	Y	Y Off	Y	Exhaust blocked, 23 occupants gone ~ 60 mins, DO, PF
15	935	ND	74	53	5	ND	2	Y	Y Off	Y	Exhaust blocked, 18 occupants gone~ 25 mins, DO, PF
16	886	ND	73	56	1	ND	0	Y	Y Off	Y	UV off/blocked, DO, exhaust blocked

ppm = parts per million
µg/m^3 = micrograms per cubic meter
ND = non-detect
AC = air conditioner
AI = accumulated items
CT = ceiling tile
DO = door open
PC = photocopier
PF = personal fan
TVOCs = total volatile organic compounds
UV = univent
WD = water damaged

Comfort Guidelines

Carbon Dioxide: < 800 ppm = preferable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Dean S. Luce Elementary School **Indoor Air Results**

Address: 45 Independence Street, Canton, MA **Table 1 (continued)** **Date: 6/1/2017**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	TVOCs (ppm)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
17	983	ND	73	57	2	ND	21	Y	Y	Y	DO, exhaust cubby used for storage
18	700	ND	73	58	1	ND	1	N	Y	Y	Dust/debris on vents
19	741	ND	73	57	1	ND	2	N	Y	Y	
22	598	ND	73	48	1	ND	1	Y	Y	Y	18 occupants gone ~10 mins, exhaust blocked by bookcase, AC filter dirty
23	665	ND	73	53	1	ND	0	Y	Y Off	Y	UV off/blocked, DO
24	1417	ND	74	58	3	ND	21	Y	Y	Y	Exhaust blocked, items in front of UV, DO
25	1162	ND	74	58	1	ND	24	Y	Y	Y	UV and exhaust blocked, feather duster, area rug, DO
26	569	ND	74	48	3	ND	1	Y	Y	Y	UV and exhaust blocked, DO, AC, 22 occupants gone ~ 1 min
27 Faculty Lunch Room	708	ND	75	50	3	ND	8	Y	Y	Y	Exhaust blocked, PC, lamination machine, plants

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Location: Dean S. Luce Elementary School **Indoor Air Results**

Address: 45 Independence Street, Canton, MA **Table 1 (continued)** **Date: 6/1/2017**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	TVOCs (ppm)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
33	592	ND	73	51	1	ND	2	Y	Y	Y	
Cafeteria	989	ND	75	52	1	ND	~100	Y	Y	Y	Dust/debris exhaust vents
34	531	ND	74	49	1	ND	0	Y	Y	Y	DO, wall AC
38	735	ND	72	53	2	ND	0	Y	Y Off	N	Plants on paper towels, AC-debris, dust/debris on windowsill
43	595	ND	73	47	1	ND	17	Y Open	Y	Y	UV blocked
44	534	ND	76	44	2	ND	0	y	Y	Y	Exhaust blocked, occupants just left for lunch
45	449	ND	75	42	1	ND	0	y	Y Open	Y	UV and exhaust blocked, occupants just left for lunch, DO
48	500	ND	74	45	2	ND	0	Y Open	Y	Y	Occupants at lunch
49	528	ND	76	43	2	ND	0	Y	Y	Y	Exhaust blocked, dust/debris UV grill, PF,

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Location: Dean S. Luce Elementary School **Indoor Air Results**

Address: 45 Independence Street, Canton, MA **Table 1 (continued)** **Date: 6/1/2017**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	TVOCs (ppm)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
											occupants just left for lunch
50	502	ND	76	42	1	ND	23	Y Open	Y	Y	DO, PF
51	670	ND	71	55	1	ND	0	N	N	N	
Media Center	548	ND	71	60	1	ND	1	Y	Y	Y	Wall to wall carpeting, hallway/entrance area of chronic leaks-stained carpet, dust/debris on vents, DO, WD CTs-hallway
56	559	ND	71	62	1	ND	4	Y	Y	Y	Dust/debris on vents, wall to wall carpeting
82	426	ND	74	50	2	ND	2	Y	Y	Y	DO
Gym	792	ND	73	61	1	ND	0	N	Y	Y	
83	607	ND	74	52	2	ND	22	Y	Y	Y	DO, PF

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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Dean S. Luce Elementary School **Indoor Air Results**

Address: 45 Independence Street, Canton, MA **Table 1 (continued)** **Date: 6/1/2017**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 ($\mu g/m^3$)	TVOCs (ppm)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
84	668	ND	74	50	1	ND	21	Y	Y	Y	DO, PF, AC (2)
87	717	ND	73	57	1	ND	23	Y	Y	Y	DO
88	549	ND	73	52	2	ND	22	Y	Y	Y	DO, AC (2)
89	579	ND	73	53	1	ND	3	Y	Y	Y	AC (2)-filters dirty, DO
92	702	ND	73	55	1	ND	0	Y	Y	Y	Box in front of UV
94	558	ND	77	47	1	ND	0	Y	Y	Y	
95	508	ND	73	52	1	ND	4	Y	Y	Y	DO
96	620	ND	74	51	1	ND	20	Y	Y	Y	Items blocking UV return, AI, DO, dust/debris on vents
97	1032	ND	74	55	2	ND	21	Y	Y	Y	DO near exhaust vent

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Carbon Dioxide: < 800 ppm = preferable
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Temperature: 70 - 78 °F
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Location: Dean S. Luce Elementary School **Indoor Air Results**

Address: 45 Independence Street, Canton, MA **Table 1 (continued)** **Date: 6/1/2017**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	TVOCs (ppm)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
100	1084	ND	72	49	1	ND	21	Y	Y Off	N	Wall to wall carpet, 2 ACs-filters dirty, PF
101	701	ND	75	53	1	ND	21	Y	Y	Y	DO, items blocking UV return
102	444	ND	76	46	3	ND	0	Y Open	Y	Y	DO, PF, dust/debris on vents
104 Storage	772	ND	74	56	2	ND	0	N	Y Passive	Y	PC, DO
108	615	ND	73	57	1	ND	0	Y	Y	Y	DO, PF

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Appendix A
Risk Factor Information for Breast Cancer

How to Use this Factsheet

This risk factor summary was developed to serve as a general fact sheet. It is an overview and should not be considered exhaustive. For more information on other possible risk factors and health effects being researched, please see the References section.

A risk factor is anything that increases a person's chance of developing cancer. Some risk factors can be controlled while others cannot. Risk factors can include *hereditary conditions*, *medical conditions or treatments*, *infections*, *lifestyle factors*, or *environmental exposures*. Although risk factors can influence the development of cancer, most do not directly cause cancer. An individual's risk for developing cancer may change over time due to many factors, and it is likely that multiple risk factors influence the development of most cancers. Knowing the risk factors that apply to specific concerns and discussing them with your health care provider can help to make more informed lifestyle and health care decisions.

For those cancer types with environmentally-related risk factors, an important factor in evaluating cancer risk is the route of exposure. This is particularly relevant when considering exposures to chemicals in the environment. For example, a particular chemical may have the potential to cause cancer if it is inhaled, but that same chemical may not increase the risk of cancer through skin contact. In addition, the dose and duration of time one might be exposed to an environmental agent is important in considering whether an adverse health effect could occur.

Gene-environment interactions are another important area of cancer research. An individual's risk of developing cancer may depend on a complex interaction between their genetic makeup and exposure to an environmental agent (for example, a virus or a chemical contaminant). This may explain why some individuals have a fairly low risk of developing cancer as a result of an environmental factor or exposure, while others may be more vulnerable.

Key Statistics

Breast cancer is the most frequently diagnosed cancer among women in the United States, except for skin cancers. The American Cancer Society estimates that in 2015, approximately 231,840 women in the U.S. and 5,890 women in Massachusetts will be diagnosed with breast cancer. The disease is expected to account for approximately 29% of all new cancer diagnoses in females.[1] Between 2007 and 2011, invasive breast cancer accounted for 29.0% of cancer diagnoses in females in Massachusetts.[11]

In the United States, breast cancer rates stabilized in the early 1990s, increased in the latter half of the 1990s, and dropped sharply between 2002 and 2003. The sharp drop has been attributed to decreased use of menopausal hormones following the 2002 publication of the Women's Health Initiative study results. This study linked the use of hormone therapy to an increased risk of breast cancer.[2] In Massachusetts, the incidence of invasive breast cancer in females remained stable over the years 2007-2011.[11]

The chance of developing invasive breast cancer at some time in a woman's life is about 1 in 8. Women are 100 times more likely than men to develop this disease.[2] Men can also develop breast cancer, but male breast cancer is rare, accounting for 1% of all breast cancer cases.[1, 9] For more information on breast cancer in men, visit the American Cancer Society website at www.cancer.org.[5]

A woman's risk of developing breast cancer increases with age. About 12-13% of invasive breast cancers are found in women younger than 45, while about 66% are found in women age 55 or older. White women are slightly more likely to develop breast cancer than women of other races and ethnicities.[2]

Types of Breast Cancer

The term "cancer" is used to describe a variety of diseases associated with abnormal cell and tissue growth. Cancers are classified by the location in the body where the disease originated (the primary site) and the tissue or cell type of the cancer (histology).

There are several types of breast cancer, although some of them are quite rare. In some cases a single breast tumor can have a combination of these types or have a mixture of invasive and *in situ* cancer.

In situ breast cancers are considered the earliest stage of cancer, when it is confined to the layer of cells where it began. They have not invaded into deeper tissues in the breast or spread to other organs in the body, and are sometimes referred to as non-invasive breast cancers.[2] The remainder of this risk factor summary pertains to invasive breast cancers. Additional information on *in situ* breast cancers and other benign breast conditions can be found at www.cancer.org (American Cancer Society).[3]

An invasive, or infiltrating, cancer is one that has already grown beyond the layer of cells where it started (as opposed to carcinoma *in situ*). Most breast cancers are invasive carcinomas – either invasive ductal carcinoma or invasive lobular carcinoma.[2]

Breast cancer most commonly involves either the milk-producing lobules or the tubular ducts that connect the lobules to the nipple.[6] Roughly 80% of all breast cancers originate in the ducts, and are known as invasive ductal carcinoma (IDC). An additional 10% begin in the lobules, and are known as invasive lobular carcinoma (ILC). Invasive lobular carcinoma may be harder to detect by a mammogram than invasive ductal carcinoma. Both types of cancer can spread (metastasize) from the original site to other parts of the body.[2, 6]

Other less common types of invasive breast cancer[2] include:

- inflammatory breast cancer
- triple-negative breast cancer
- medullary carcinoma
- metaplastic carcinoma
- mucinous carcinoma
- Paget's disease

- tubular carcinoma
- papillary carcinoma
- Phyllodes tumor
- adenoid cystic carcinoma or adenocystic carcinoma
- angiosarcoma

Established Risk Factors

Hereditary Conditions

Having a family history of breast cancer increases a woman's risk of developing the disease. Women who have a first-degree relative (i.e., mother, sister) with breast cancer have about twice the risk of developing breast cancer themselves. Having two first-degree relatives with this disease increases a woman's risk by three- to five-fold.[2, 6] The risk is also elevated if several close relatives from either side of the family have been diagnosed with breast or ovarian cancer, especially before age 50.[6, 13] Overall, less than 15% of women with breast cancer have a family member with the same disease. Therefore, over 85% of women who have breast cancer have no familial link to the disease.[2]

About 5-10% of breast cancer diagnoses are thought to be due to an inherited genetic mutation.[2, 15] Most of these mutations occur in the *BRCA1* and *BRCA2* genes. Other genes that may lead to an increased risk for developing breast cancer include *ATM*, *CHEK2*, *TP53* and *PTEN*. Women who inherit these gene mutations have up to an 80% chance of developing breast cancer during their lifetime.[2]

Medical Conditions and Treatments

Certain benign breast conditions may increase one's risk for breast cancer. Women with proliferative lesions without atypia (i.e., abnormal or unusual cells), which have excessive growth of cells in the ducts or lobules of breast tissue, are 1.5 to 2 times more likely to develop breast cancer compared with women who have non-proliferative lesions.[15] Proliferative lesions with atypia, when the cells are excessively growing and no longer appear normal, raise one's risk by 3.5 to 5 times. Women with denser breast tissue (as seen on a mammogram) have more glandular tissue and less fatty tissue, and have a higher risk of breast cancer.[2]

A woman with cancer in one breast is 3 to 4 times more likely to develop a new cancer in the other breast or in another part of the same breast. In addition, a previous diagnosis of an *in situ* breast cancer puts a woman at increased risk for an invasive breast cancer.[2]

Cumulative exposure of the breast tissue to estrogen is associated with breast cancer risk. Several factors can influence estrogen levels. Women who started menstruating at an early age (before age 12) and/or went through menopause at a later age (after age 55) have a slightly higher risk of breast cancer. Also, women who have had no children or those whose first pregnancy occurred when they were over the age of 30 have an increased risk for developing breast cancer.[2] Women who have had more children and those who have breast-fed seem to be at lower risk.[15]

Use of hormone replacement therapy is another factor that may affect breast cancer risk. Long-term use (several years or more) of combined post-menopausal hormone therapy (PHT) increases the risk of breast cancer. The increased risk from combined PHT appears to apply only to current and recent users. A woman's breast cancer risk seems to return to that of the general population within 5 years of stopping combined PHT. The use of estrogen-only replacement therapy (ERT) does not appear to increase the risk of breast cancer significantly but when used long-term (for more than 10 years), ERT has been found to increase the risk of ovarian cancer in some studies.[2, 15]

Women who had radiation therapy to the chest area as treatment for another cancer (i.e., ionizing radiation for Hodgkin disease) are at significantly increased risk for breast cancer.[15] This risk appears to be highest if the radiation is given during adolescence or puberty, when the individual's breasts are developing.[2]

From the 1940s through the 1960s some pregnant women were given the drug diethylstilbestrol (DES) because it was thought to lower their chances of miscarriage. These women have a slightly increased risk of developing breast cancer. A woman whose mother took DES while pregnant may also have a slightly higher risk of breast cancer.[2]

Lifestyle Factors

Alcohol consumption has also been associated with increased risk for breast cancer. Compared with non-drinkers, women who consume one alcoholic drink a day have a very small increase in risk whereas those who have 2 to 5 drinks daily have about 1½ times the risk of women who drink no alcohol.[2]

Possible Risk Factors

Environmental Exposures

A great deal of research has been reported and more is being done to understand possible environmental influences on breast cancer risk. Of special interest are compounds in the environment that have been found in animal studies to have estrogen-like properties, which could in theory affect breast cancer risk. For example, substances found in some plastics, certain cosmetics and personal care products, pesticides (such as DDE), and PCBs (polychlorinated biphenyls) seem to have such properties. To date, however, there is not a clear link between breast cancer risk and exposure to these substances.[2]

Lifestyle Factors

For a long time, the role of cigarette smoking in the development of breast cancer was unclear. Recent research, however, supports a consistent association between smoking and an increased risk of breast cancer, with long-term heavy smokers at highest risk.[16, 2]

Some studies suggest a relationship between secondhand smoking and an increased risk for breast cancer; however, confirming this relationship has been difficult and is still the subject of active research.[2, 15, 16]

Recent studies have indicated that being overweight or obese after menopause may put a woman at increased risk of breast cancer.[2, 6, 15] Similarly, women who are physically inactive throughout life may have an increased risk of breast cancer.[2]

Studies have found that women using oral contraceptives (birth control pills) have a slightly greater risk of breast cancer than women who have never used them, but this risk seems to decline once their use is stopped. Women who stopped using oral contraceptives for more than 10 years do not appear to have any increased breast cancer risk. When thinking about using oral contraceptives, women should discuss their other risk factors for breast cancer with their physician.[2]

Lifetime risk of breast cancer is increased in women of higher socioeconomic status (SES) (e.g. income, education). Research suggests that this may be due to reproductive and lifestyle factors (age at first full-term birth, physical activity, diet, cultural practices, etc.).[6, 15]

Several recent studies have also suggested that working the night shift may be associated with an increased risk of breast cancer. The light-sensitive hormone melatonin may play a role in this link, and further research is being conducted in this area.[2, 10]

Other Risk Factors That Have Been Investigated

Lifestyle Factors

Though links have been suggested, antiperspirants, bras, and breast implants have all been investigated as possible risk factors for breast cancer but no associations have been found.[2, 15]

Dietary fat intake is another factor that has been suggested to increase a woman's risk for breast cancer. Though studies have found decreased breast cancer rates in countries with a diet typically lower in fat, studies in the U.S. have not shown an association between the amount of fat in the diet and increased risk of breast cancer.[2, 15]

References/For More Information

Much of the information contained in this summary has been taken directly from the following sources. This material is provided for informational purposes only and should not be considered as medical advice. Persons with questions regarding a specific medical problem or condition should consult their physician.

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